



Vision Performance Institute

Technical Report

Emphasis Techniques in Presentations: Effectiveness & Recall

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Abstract

The use of computer presentation software, such as Microsoft PowerPoint or Apple's Keynote, is widespread across nearly every discipline. When used effectively, well designed computer presentations are excellent aids to lectures and presentations. When poorly designed, computer presentations have the potential to lessen the value of the presentation. To date, little has been studied on the effectiveness of various typographical emphasis techniques. The purpose of this study was to compare the effectiveness of common chromatic and achromatic typographical emphasis techniques used in computer presentations in terms of response time and recall. To achieve this, two experiments were performed. In the first experiment, subjects were presented with a series of computer presentation slides in which one of 49 words was emphasized in one of the following ways: bold, italic, underline, all capital letters, red, yellow, green or blue text. The subject was asked to locate and speak the emphasized target word, and a computer recorded the subjects' reaction times. These conditions were tested across three different backgrounds common to computer presentations: white, black, and dark blue. In the second experiment, subjects were asked judge the frequency that words from the first experiment appeared. It was found that for emphasizing text, chromatic emphasis techniques are

generally more effective than achromatic emphasis techniques. Our research also indicates that it is necessary to maintain proper contrast when colors are used.

Introduction

The use of computer presentation software, such as Microsoft PowerPoint or Apple's Keynote, is widespread across nearly every discipline. Its effectiveness as a presentation aid has been widely debated, with a plethora of opinions both for and against its use. A series of surveys involving more than 1500 students and faculty at the University of Tennessee at Chattanooga found that while most favor its use in a classroom setting, the majority of negative responses to Microsoft PowerPoint presentations are due to its ineffective use by the presenter (such as poor slide design and presenter reading slides to the audience)¹. Edward Tufte states that "at a minimum, a presentation format should do no harm. Yet the PowerPoint style routinely disrupts, dominates, and trivializes content. Thus PowerPoint presentations too often resemble a school play - very loud, very slow, and very simple²." The opinion of what constitutes a 'good' or 'professional' computer presentation varies from presenter to presenter; however, most authors agree on several guidelines when designing computer presentations: no more than 5-7 lines per slide (including the title), no more than 5-7 words per line, the use of sans serif fonts (such as Verdana and Arial, as opposed to Times New Roman), a limit of 3-4 colors per slide, and the use of typographical components to stress key learning points^{1,3-5}. Little has been studied on the effectiveness of various typographical emphasis techniques. Previous studies have shown that reaction times of eye movements, verbal responses, and mechanical responses are somewhat slower to chromatic stimuli than achromatic stimuli (by about 50msec), apparently due to latency differences in the parvocellular (chromatic) and magnocellular (achromatic) visual pathways⁶. However, there have been no scientific studies comparing differences among typographical emphasis techniques, chromatic or otherwise. The purpose of this study was to compare the effectiveness of

common chromatic and achromatic typographical emphasis techniques used in computer presentations in terms of response time and recall.

Methods

Subjects. Thirty subjects (age 18 to 35) were recruited from Pacific University. They were screened to meet the following criteria: binocular vision with uncorrected or corrected visual acuity of 20/20 or better with both eyes open, normal color vision (measured binocularly by pseudoisochromatic plates), no ocular pathology, native English speakers, and no known cognitive deficits. Study protocols were approved by the Institutional Review Board of Pacific University and all subjects gave written consent before the study. Students were given extra credit in optometry related coursework for participation.

Stimuli. Each participant was presented a series of 336 computer presentation slides on a 19-inch LCD Sceptre S1902D monitor at eye level at a distance of 100cm. Each slide was created with 18 point size lowercase Verdana font, which corresponded to a Snellen equivalent visual acuity demand of approximately 20/70. Each slide contained 49 five to seven letter words. The words were organized in a table so that there were exactly seven words in each column and seven words in each row; there were no visible lines separating the cells of the table. Of the words that were presented on each slide, 48 were distracter words and one was the emphasized target word. The emphasized target word utilized one of eight typographical emphasis techniques: bold, italic, underline, all capital letters, red, yellow, green, or blue text. Each emphasis style was tested on three different backgrounds common to Microsoft PowerPoint presentations: white, black, and dark blue. Colors on a computer can be specified by the amount of red, green, and blue light mixed to create the color. This specification is known as an *RGB value*, and is a triplet that indicates the relative amounts of red, green, and blue used to create the color. The maximum value for each number in the triplet is 255, and the minimum value is zero⁷. The following RGB values were used to define colors used in this experiment: white (255, 255, 255), black (000, 000, 000), red (255, 000, 000), yellow (255, 255,

000), green (000, 255, 000), blue (000, 000, 255), and dark blue (031, 075, 125). Except for the chromatic emphasis conditions, the words displayed on the black and dark blue backgrounds were of white text, and the words displayed on the white background were of black text. The horizontal and vertical location of the emphasized target word was randomly chosen on each slide. The 48 distracter words on each slide were chosen at random from a list of 400 high or low frequency words that were selected carefully to ensure no categorical or other similarities to the emphasized target words. For the purposes of this experiment, low frequency words were randomly chosen from words appearing less than 1% of the time in a standardized word list and high frequency words chosen from words appearing more than 1% of the time on the same standardized word list⁸. The distracter words on each slide were of similar word frequency as the emphasized target word. The emphasized target words were chosen at random from a list of 168 high frequency and 168 low frequency words, also selected carefully to ensure no categorical or other similarity to other emphasized target words or distracter words. Each participant was shown the same target words, but the method of emphasis varied across subjects. For instance, the word *cannon* may appear as bold text on a white background for one subject, but may appear as red text on a dark blue background for the next. Figures 1 and 2 below show examples of the stimuli.

hundred	father	through	policy	summer	student	reading
really	program	maybe	effect	easily	still	radio
being	mother	theory	often	story	merely	income
nuclear	party	given	ahead	sense	miles	might
thing	value	became	whose	large	report	having
service	basis	voice	before	purpose	corner	across
heard	expect	early	least	where	country	period

Figure 1. Computer presentation slide displaying the emphasized target word “miles” in bold text on a white background.

willing	region	beauty	frank	coffee	pulled	belief
failed	dress	yards	senate	capable	replied	kitchen
valley	reality	animals	plenty	sources	initial	session
somehow	sleep	horses	fourth	murder	wonder	prices
fellow	passing	shape	stories	plants	shook	signal
finds	divided	useful	regular	formed	weight	fashion
civil	master	perfect	accept	equally	stayed	secret

Figure 2. Computer presentation slide displaying the emphasized target word “reality” in red text on a dark blue background.

Procedure. Reaction times were measured for eight forms of emphasis: bold, italic, underline, all capital letters, red, yellow, green, and blue on three different backgrounds (white, black, and dark blue). The participant was asked to speak the emphasized target word presented and the participant's reaction time was recorded with a voice-activated and head-mounted microphone. After the emphasized word was spoken, a grey screen with a black central fixation cross (+) was shown for 500msec, and the next slide was displayed. Each participant was instructed to look at the central fixation cross presented between each slide. After the participant spoke the emphasized target word, the examiner recorded if the response was correct. The emphasized target word, the emphasis mode, the background color, the horizontal and vertical location of the emphasized target word, the subject's reaction time, and the correctness as indicated by the examiner were recorded in a computer. Each emphasis mode/background combination was tested 14 times in random order, for a total of 336 presentation slides. Before the testing sequence began, a practice round consisting of 10 slides was presented to the participant.

After the first experiment, the participant was given a timed five minute break and offered a drink of water. Then a series of 168 slides with two words were presented to the participant. Each slide was presented on a computer with a white background with words in black 24 point Verdana font. The participant was asked to judge which of the two words appeared more frequently in the first experiment. The subject indicated their choice by pressing one of two keys on a keyboard. The two words on the slide were selected from differing conditions from the first experiment. High frequency words were compared with high frequency words, and low frequency words compared with low frequency words. In addition, the words were selected to compare similar backgrounds. For example, a high frequency word that had appeared with red emphasis text on a white background was compared with a high frequency word that had appeared with bold text on a white background. Low frequency words were not compared with high frequency words, and words presented on the black background were not compared

with words presented on white or dark blue backgrounds. Each word had been presented only once during the first part of the experiment, hence the participant was required to make a forced choice between two words that had been shown only once. The purpose of this forced choice judgment was to determine if there was a significant difference in the ability to recall words of a specific emphasis technique. After answering the 168 questions, the participant's participation in the study was complete.

Results

Across the thirty subjects 10,080 stimulus conditions were presented; 643 were removed from analysis because of an incorrect response. The geometric mean response time was used as a measurement of emphasis effectiveness. Figures 3, 4, and 5 below show the geometric mean response times across subjects. Upper and lower bars represent a 95% confidence interval and the middle bar represents the geometric mean across subjects. Non-overlapping bars indicate significance at $p < 0.05\%$.

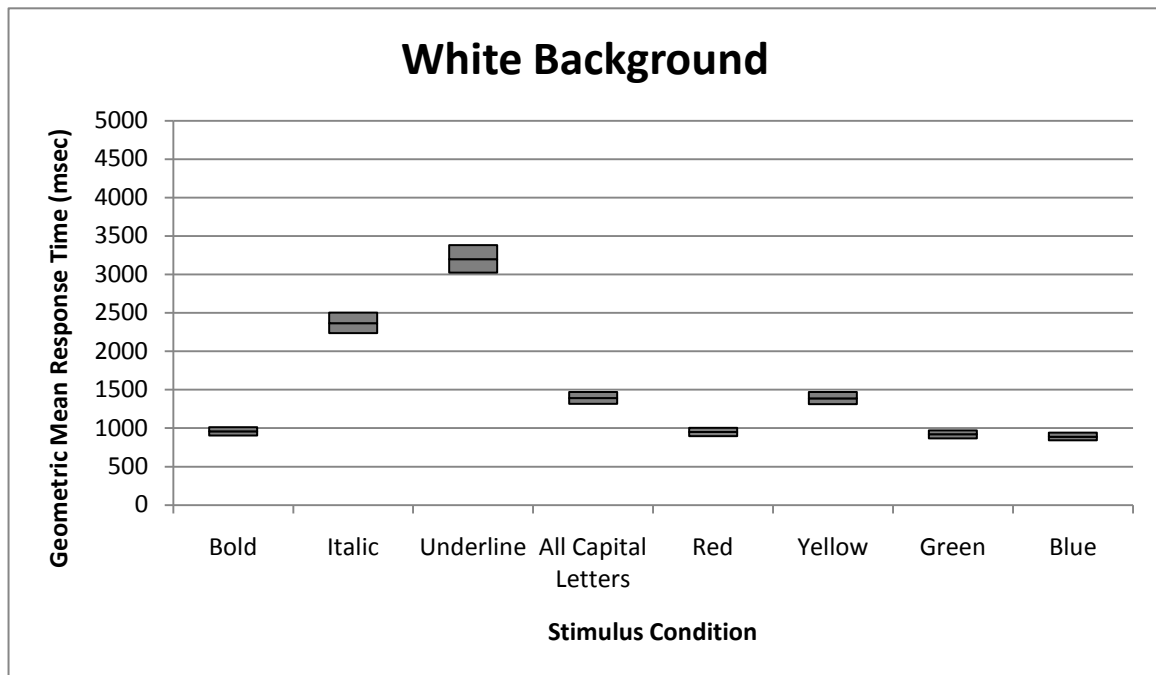


Figure 3. Average response times for emphasis techniques on a white background.

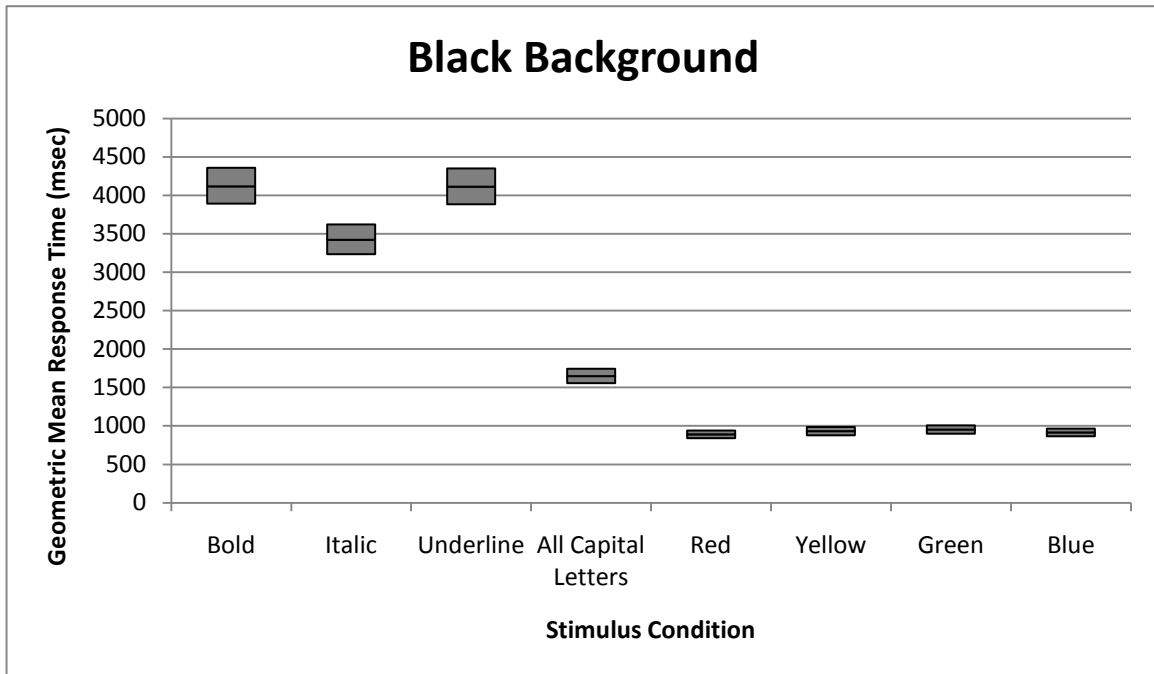


Figure 4. Average response times for emphasis techniques on a black background.

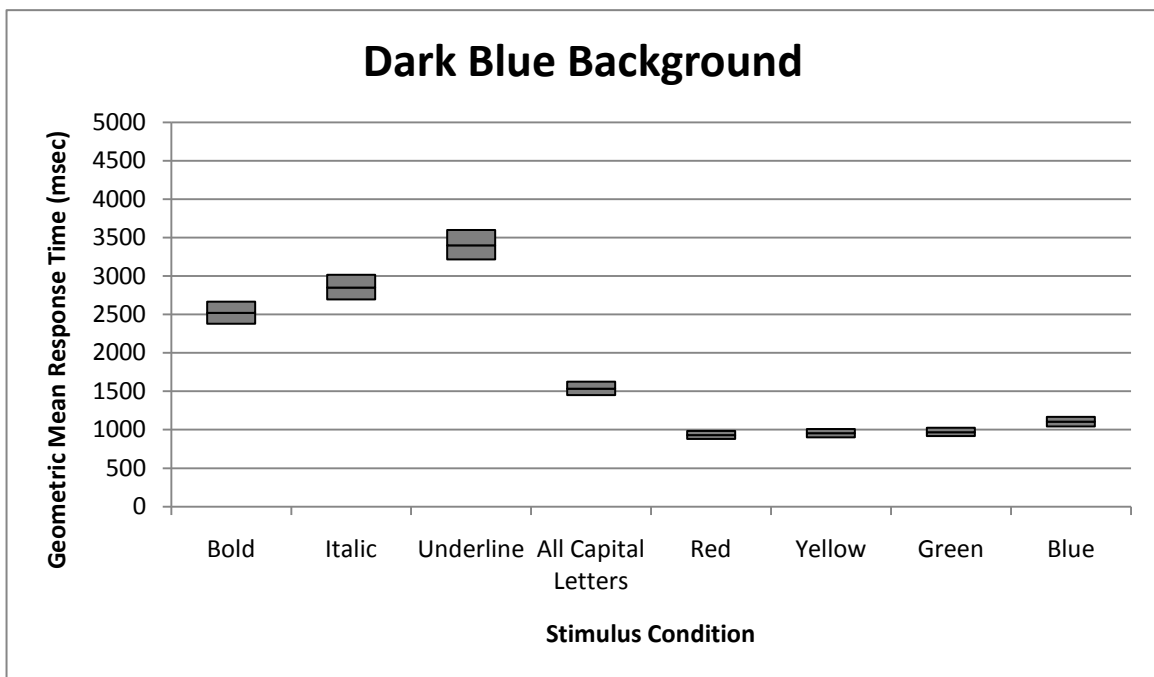


Figure 5. Average response times for emphasis techniques on a dark blue background.

Generally, chromatic emphasis techniques resulted in significantly faster reaction times than achromatic emphasis techniques. The exception to this was bold text on a white background, which elicited a reaction time

similar to the chromatic stimuli; however, bold text on black and dark blue backgrounds elicited a significantly slower reaction than chromatic emphasis techniques. Underline and italic emphasis techniques were consistently the least effective means of emphasizing text. Using all capital letters elicited nearly the same reaction time regardless the background, and was the quickest achromatic emphasis response time on the black and dark blue backgrounds. Yellow text on a white background and blue text on dark blue background were the least effective chromatic emphasis styles, most likely due to their poor chromatic contrast. However, even poor chromatic contrast elicited quicker responses than most achromatic stimuli. Overall, blue text on a white background was the most effective emphasis technique. In terms of reaction time, no significant difference was found when analyzed for word frequency or location of the emphasized word.

In terms of recall, there was no significant difference among individual emphasis techniques. Additionally, there was no significant difference in recall when analyzed across background color, word frequency, or chromaticity.

Discussion

In typography, emphasis is created by using color, typeface (bold, italic, and underline), or all capital letters to differentiate a word from surrounding words⁵. Our first experiment was a measurement of the time it took for the participant to quickly localize and verbalize the singular word that was different than the surrounding words. Therefore, reaction time can be considered a reliable psychophysical measurement of emphasis effectiveness⁹.

Our findings support the recommended use of color to emphasize text when giving computer based presentations^{1,3,4}. Additionally, the relatively slower reaction times to yellow-on-white and blue-on-dark blue stimuli also support the recommendation that proper color contrast is necessary for the most effective presentation design^{3,10}. When designing a presentation with a white background, bold text may also be used as an effective emphasis technique. However, boldface text is not recommended for use as an

emphasis technique for dark backgrounds. The differences in reaction times of boldface text between background conditions may be due to the experience of English readers of printed text. It is very common for published text to use boldface type to emphasize words or ideas, as it has been historically easier and less costly than using printed chromatic emphasis techniques⁵. With this in mind, it may be that participants have experience localizing boldface black text, but not boldface white text. Using all capital letters seems to be consistently effective at emphasizing text across background conditions. This may be because capital letters are taller and wider than lower case letters, providing an easier stimulus for localization. However, capital letters are still less effective at emphasizing text than color. Additionally, the use of all capital letters is traditionally reserved for titles⁵, and their use in other circumstances may be misinterpreted as 'yelling' or 'shouting'¹¹. The use of italic or underline text is not recommended unless only subtle emphasis is desired.

Our results differ from previous comparisons between chromatic and achromatic targets that measured saccadic eye movement reaction times to various colored, black, or white blocks⁶. This can be explained in that our investigation differed in both design and measurement from previous saccadic latency studies. While previous studies looked at reaction time of eye movements to simple stimuli and required little cortical processing, our experiment was a measurement of the total time it took to localize, identify, and verbalize a word. This figure-ground discrimination task differs significantly from previous saccadic latency experiments. The significant differences in reaction times among various stimuli are most likely due to the length of time it takes to localize the emphasized word, and not differences between the magnocellular and parvocellular visual pathways. There was no significant difference in recall among individual emphasis techniques. This is most likely due to the fact that during the first experiment, the participant was only instructed to localize and verbalize the emphasized words, not to remember them for later recall. This reinforces the idea that the content of the presentation, effectiveness of the speaker, and attentiveness of the

audience is of great importance when using computer based presentations^{1,10,11}.

Conclusion

Well designed computer presentations are excellent aids to lectures and presentations. Our research indicates that using color to emphasize text is the most effective emphasis technique. No significant difference was found among different colors, provided that proper color contrast is taken into account to ensure legibility. Using all capital letters, typically reserved for titles, is of moderate emphasis effectiveness and was overall the fastest achromatic emphasis technique. Boldface text should be used with caution, as it is effective when used with black text, but loses effectiveness when white text is used. Italics and underline were consistently poor performers at emphasizing text. In terms of recall, there was no significant difference across emphasis techniques.

Acknowledgement

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